

REMARKS

Reconsideration and allowance of this application are respectfully requested in light of the foregoing amendments and the following remarks.

Claim Status

Claim 1 was amended and claims 17-18 were added. Claim 13 was cancelled. Claims 1-12 and 14-18 are pending. No new matter was added. Basis for new claims 17-18 may be found in the specification in the paragraph bridging pages 6-7, in the paragraph bridging pages 7-8 and at the end of the 2nd paragraph on page 8.

§102/103 Claim Rejections

Claims 1, 4, 8-12, 14 and 16 stand rejected under 35 U.S.C. §102(e) as being anticipated by or, in the alternative, under 35 U.S.C §103(a) as obvious over U.S. Patent Application No. 2004/0045897 (hereinafter Nakabayashi) as evidenced by Developments in Medical Polymers for Biomaterials Applications, KATZ (hereinafter Katz). Applicant traverses.

As stated in the previous office action, to anticipate a claim under 35 U.S.C. §102(b), a single source must contain all of the elements of the claim. *See Hybritech Inc. v. Monoclonal*

Antibodies, Inc., 802 F.2d 1367, 1379, 231 USPQ 81, 90 (Fed. Cir. 1986); *Atlas Powder Co. v. E.I. du Pont De Nemours & Co.*, 750 F.2d 1569, 1574, 224 USPQ 409, 411 (Fed. Cir. 1984); *In re Marshall*, 578 F.2d 301, 304, 198 USPQ 344, 346 (C.C.P.A. 1978). Missing elements may not be supplied by the knowledge of one skilled in the art or the disclosure of another reference. See *Structural Rubber Prods. Co. v. Park Rubber Co.*, 749 F.2d 707, 716, 223 USPQ 1264, 1271 (Fed. Cir. 1984). Where a reference discloses less than all of the claimed elements, an Examiner may only rely on 35 U.S.C. §103. See *Titanium Metals Corp. v. Banner*, 778 F.2d 775, 780, 227 USPQ 773, 777 (Fed. Cir. 1985).

The Examiner considered Applicant's arguments regarding claim 1, but did not find them persuasive. Specifically, the Examiner argues that while the zwitterionic compound of Nakabayashi has a zero net charge, the zwitterionic negative charge on the compound renders the application at a minimum obvious and in the alternative anticipatory. The Examiner, however, has overlooked numerous relevant facts. For instance, both claim 1 and claim 9 require the employment of a polyelectrolyte with negative fixed charges. The increase in separation efficiency of the membranes of the instant invention are realized only when polyelectrolytes having negative fixed charges are used. In contrast, if polyelectrolytes having

positive fixed charges are added to the interior filler, the resulting membranes show no increased separation efficiency. (Specification, Page 5, Paragraph 1). This statement may be interpreted in two ways.

The first interpretation being that as soon as there is any positive fixed charge in the polyelectrolyte molecule, the resulting membranes do not show improved separation efficiency (thus failing to achieve the object of the invention). This interpretation excludes any zwitterion because a zwitterion has positive charges beside the negative charges.

Secondly, the term "polyelectrolyte with negative fixed charges" is interpreted that beside negative fixed charges, the polyelectrolyte may also carry positive fixed charges. In this case, however, the term "polyelectrolyte with positive fixed charges" must be interpreted such that this polyelectrolyte may also carry negative fixed charges. However, it is clearly disclosed in the instant application that polyelectrolytes with negative fixed charges lead to enhanced separation efficiency, while polyelectrolytes with positive fixed charges do not. Therefore, there must be a significant difference between these two groups of polyelectrolytes which, as a consequence, means that they must distinguish in their net charge. Thus, according

to this interpretation, the polyelectrolyte with negative fixed charges must have a negative net charge. This interpretation again excludes the zwitterion of Nakabayashi because it possesses a net zero charge.

Another relevant fact ignored by the Examiner is that according to the instant invention, a polyelectrolyte with a negative fixed charge is employed. Nakabayashi, however, does not disclose a polyelectrolyte. Those of skill in the art know that "an electrolyte is any substance containing free ions that make the substance electrically conductive." (See enclosed definition of electrolyte from Wikipedia). Looking to Hackh's Chemical Dictionary, an electrolyte is "a substance that dissociates into 2 or more ions, to some extent, in water. Solutions of electrolytes thus conduct the electric current and can be decomposed by it. (See enclosed definition from Hackh's Chemical Dictionary, McGraw-Hill Book Company, Pages 234-35, (1969)). Moreover, looking to the same source, a polyelectrolyte is "a polymer producing large chain-type ions in solutions, that can carry positive or negative groups along the polymer chain." (emphasis added - Page 533). No where within these passages is it stated that a polyelectrolyte can carry "positive and/or negative groups...". Looking now to the enclosed passages from Fumio Oosawa's textbook on polyelectrolytes, we

read that "polyelectrolytes are macromolecules having many ionizable groups. In solution they are dissociated into polyvalent macroions (polyions) and a large number of small ions of opposite charge (counter ions). (Fumio Oosawa: "Polyelectrolytes"; Marcel Dekker, Inc., New York, Page 1 (1971)).

The above definitions are contrasted by the MPC co-polymer or Nakabayashi which is a zwitterion and, as admitted by the Examiner, therefore has zero net charge. Looking to the enclosed printout from Wikipedia, "a zwitterion is a chemical compound that carries a total net charge of zero and is thus electrically neutral, but carries formal charges on different atoms." (See enclosed definition of zwitterion from Wikipedia). Thus, zwitterions carry positive and negative groups. In solution, zwitterions are **not** dissociated into polyvalent macroions (polyions) and a large number of small ions of opposite charge (counter ions). Both ions are bound to the same molecular backbone, each localized at a different point in the molecule. **Therefore, zwitterions lack the ability to conduct electric current.** In summary, a zwitterion is not a polyelectrolyte and therefore is not a polyelectrolyte with negative fixed charges according to claim 1 of the instant

invention. Thus, claim 1 of the instant invention is not anticipated by Nakabayashi and should be allowed.

Despite the claim to the contrary by the Examiner, claim 1 of the instant invention is also not obvious over Nakabayashi. Nakabayashi provides no hint or motivation that by using a polyelectrolyte, let alone a polyelectrolyte with negative fixed charges, one may obtain a membrane having improved separation efficiency. Nakabayashi specifically deals with hollow fiber membranes consisting of a copolymer of MPC and other vinyl-polymerizable monomers as additives in a higher concentration on the inside and/or the outside surface of the membrane than the other parts of the membrane. (Nakabayashi, Claim 1)

Additionally, Nakabayashi clearly states on Page 4, Paragraph 38 that:

...the hollow fiber membrane can be modified in the present invention by unevenly distributing the MPC copolymer on the membrane surface. Such a hollow fiber membrane can be obtained by a method of causing the MPC copolymer adsorbed on the surface of a previously manufactured hollow fiber membrane, as mentioned above, or by a method of unevenly distributing the MPC copolymer on the membrane surface when the membrane is manufactured.

The membranes of Nakabayashi shall be used for e.g. hemodialysis or blood filtration whereby the membranes are made from a synthetic polymer.

By adding the MPC copolymers, membranes shall be provided with a surface exhibiting only small interaction with biological components and excelling in biocompatibility. (Nakabayashi, Page 2, Paragraph 10). Nakabayashi is absolutely silent concerning separation behavior of the membranes, let alone the separation efficiency of the membranes. A person skilled in the art is left in the dark on how to modify the teachings of Nakabayashi in order to obtain membranes having improved separation efficiency such as those disclosed within the instant invention. Nakabayashi contains neither reason nor motivation for one skilled in the art to alter the process and membranes described therein by using polyelectrolytes with negative fixed charges as an alternative to the MPC copolymers with are zwitterions having zero net charge in order to obtain membranes with improved separation efficiency. Thus, claim 1 of the instant invention is not obvious over Nakabayashi and should be allowed.

Looking now to claim 4 of the instant invention, the meaning behind the Examiner's rejection is difficult to ascertain. On Page 9 in her "Response to Arguments" section, the Examiner refers to Page 5, Paragraph 44 of Nakabayashi. However, in the Applicant's humble opinion, this passage has no relevance with respect to claim 4 of the instant invention.

Paragraph 44 of Nakabayashi discloses a process for manufacturing the membranes of Nakabayashi, wherein a readily prepared hollow fiber membrane is after-treated with a solution of the MPC copolymer in a suitable solvent, whereby the solution of the MPC copolymer is caused to come into contact with the membrane surface, thereby causing the MPC copolymer to be absorbed.

This process has nothing in common with claim 4 of the instant invention which depends from claim 1. Specifically, claim 4 relates to a method for production of an integrally asymmetric membrane, wherein during manufacturing of the membrane, a polyelectrolyte with negative fixed charges is introduced into the membrane structure. More specifically, according to amended step c, the first and/or second surface of the shaped spinning solution is brought into contact with a precipitant system, whereby a membrane with a separation layer is formed and whereby this precipitant system contains the polyelectrolyte with negative fixed charges and wherein according to claim 4 this polyelectrolyte is not soluble in the spinning solution, but instead precipitates in contact with the spinning solution.

Thus, while Paragraph 44 of Nakabayashi related to an after-treatment of a readily prepared membrane, the instant invention related to the addition of a polyelectrolyte **during the formation of a membrane.**

Looking now to the Examples referred to by the Examiner, and in particular Example 1 of Nakabayashi. There is neither a disclosure that the dissolved interior filler precipitates in contact with the spinning solution, nor is there a disclosure that is occurs as the spun raw material is passed through a water bath. Applicant has no insight as to the Examiner's basis for this interpretation of Nakabayashi. According to Example 1, a spinning solution ("membrane-forming raw material solution") was discharged from spinnerets with an annular orifice. This, the spinning solution is formed into a hollow fiber. In addition to the annular orifice, the spinneret for producing hollow fiber membranes in the center of the annular orifice has an inner opening via which an interior filler ("hollow space inner solution"/"internal coagulate solution") is discharged simultaneously with the spinning solution. The interior filler both 1) forms the hollow space or lumen of the hollow fiber, and 2) acts as a coagulant for the polymer which is dissolved in the spinning solution, thereby forming e.g. a separating layer. The spun yarns, i.e. the spinning solution in the form of a hollow

fiber, together with the interior filler in the lumen, are then immersed in an (outer) coagulation bath located below the spinning nozzles. (See Page 2, Paragraph 15, Lines 1-8 and Pages 4-5, Paragraph 40, Lines 4-13).

Thus, according to the disclosure of Nakabayashi, the membrane forming polymer in the spinning solution coagulates on contact with the interior filler. During the coagulation of the membrane forming polymer, the MPC polymer is entangled with molecular chains of the membrane forming polymer or incorporated into dense structure near the inner surface. Please also see pages 10-12 of the previous Amendment submitted by Applicant concerning Claim 4 of the instant invention. Contrary to the Examiner's assertion to the contrary, there is not disclosure within Nakabayashi of a polymerization.

In reference to claims 4, 8-12, 14 and 16, "[I]f an independent claim is not anticipated by prior art, then its dependent claims, which necessarily include the limitations of the independent claim, are not anticipated either. *Kovin Assoc. v. Extech/Exterior Technologies*, 2006 U.S. Dist. LEXIS 63250 (N.D. Ill. 2006), citing *Trintec Indus., Inc. v. Top-U.S.A. Corp.*, 295 F.3d 1292, 1296 (Fed. Cir. 2002). Thus, claims 4, 8-

12, 14 and 16 are not unpatentable over Nakabayashi and should be allowed.

§103 Claim Rejections

Claims 1-12 and 14-16 stand rejected under 35 U.S.C. §103(a) as being obvious over U.S. Patent No. 4,604,208 (hereinafter Chu) in combination with U.S. Patent Application No. 2004/0045897 (hereinafter Nakabayashi). Applicant traverses.

The above comments regarding Nakabayashi and Katz are incorporated herein. It is with all due respect to the Examiner that Applicant expresses the deepest confusion as to the Examiner dismissing the arguments set forth in the previous office action regarding both the Chu and Nakabayashi references. The Examiner's claim that one skilled in the art would be motivated to combine the teachings of Chu with the teachings of Nakabayashi in order to improve the efficiency of the process disclosed in Chu would in no way achieve the integrally asymmetric membrane with improved separation efficiency as is described in the instant application.

As was clearly stated above, Nakabayashi does not disclose the use of polyelectrolytes with negative fixed charges, but

instead makes use of zwitterions. (Please see the detailed arguments presented above). Additionally, the goal of the instant invention is to provide integral asymmetric membranes having improved separation efficiency. This is contrary to the membranes described by Chu, (i.e. membranes which after having been completely precipitated are provided with a polyelectrolyte) which do not show an improvement in separation efficiency due to the interlocking and entanglement of the polymer chains of the polyelectrolyte with those of the membrane forming polymer being hardly possible. (Specification, Page 15, Paragraph 1). Chu also fails to address any of the aspects of separation characteristics of the membranes. Chu instead discloses membranes aimed at solving the problem of bacterial breakthrough. (Column 1, Lines 38-61, Column 2, Lines 2-5). Chu also seeks to produce membranes for the removal of fine charged particulates from liquids. (Column 2, Lines 61-66, Column 5, Lines 23-35). In fact, Chu discloses a process for the modification of readily prepared membranes by treating these membranes with an aqueous solution of an anionic charge modifying agent, (e.g. by immersing the membrane into this aqueous solution). This is in contrast to Nakabayashi which discloses a hollow fiber membrane spinning process in which an MPC copolymer is given to the inner filler (internal coagulate solution). The processes do not have anything in common with

one another. Therefore, using Chu as a starting point, there is neither reason nor motivation for a person of ordinary skill in the art to conclude that adding a polyelectrolyte with negative fixed charges to the inner filler would result in a membrane with enhanced separation efficiency. Starting with Chu, it is far from routine for one skilled in the art to produce a membrane as described in claim 1 of the instant invention.

It is unclear to the Applicant how there may be a suggestion to improve the efficiency of the process by discharging a modifying agent in the inner lumen during production of the membrane, thereby reducing the number of steps as is alleged by the Examiner. Applicant believes that whether or not such a suggestion exists, must first be judged by beginning from Chu. Even if it were the case that a reduction of the number of steps did occur, the change in the process resulting from adding the modifying agent to the "core liquid" instead of the solution of the film forming polymer in a solvent system (as is done by Chu) would result in membranes undesired by Chu. Chu seeks to produce membranes modified with a modifying agent which is bound to substantially all of the internal microstructure of the microporous membrane. (Column 5, Lines 39-45, Column 9, Lines 15-ff). This is important to Chu in order to solve the problems according to the invention of

Chu, i.e. to have a decreased adsorptive capacity for anionic submicronic particulate due to the fact that these anionic particulates are often desirably retained in the liquid to be filtered. (Column 13, Lines 32-42). However, in order to have a reduced adsorptive capacity for anionic submicronic particulate, substantially all of the internal microstructure has to be modified.

When applying the process of Nakabayashi, only the surface of the membrane is modified which leaves the rest of the membrane structure intentionally unmodified. However, a membrane being modified in this manner does not have a decreased adsorptive capacity. Therefore, even if there were a reduction of process steps, a person of ordinary skill in the art, if beginning from Chu's process, would never apply the process of Nakabayashi.

This leads the Applicant to question whether there is actually a reduction of process steps as is alleged by the Examiner. In the Applicant's opinion, the process of Chu and Nakabayashi are too different and cannot be compared by comparing the number of process steps. As previously mentioned, Chu discloses a process for the modification of readily prepared microporous membranes. (Column 11, Line 56 - Column 12, Line

3). This has the advantage of modifying e.g. all kinds of commercially available membranes in an after-treatment process. Nakabayashi, in contrast, related to processes during which formation of the membrane and formation of the modified surface occur simultaneously. Such a process in general is quite restricted with respect to the effective degrees of freedom to operate. Additionally, Nakabayashi regards these processes as being alternatives. (Page 2, Paragraph 15-16, Page 5, Paragraph 44).

The prior art reference or combination of references relied upon by the Examiner must teach or suggest all of the limitations of the claims. See *In re Zurko*, 111 F.3d 887, 888-89, 42 U.S.P.Q.2d 1467, 1478 (Fed. Cir. 1997); *In re Wilson*, 424 F.2d 1382, 1385, 165 U.S.P.Q. 494, 496 (C.C.P.A. 1970) ("All words in a claim must be considered in judging the patentability of that claim against the prior art."). The teachings or suggestions, as well as the expectation of success, must come from the prior art, not applicant's disclosure. See *In re Vaeck*, 947 F.2d 488, 493, 20 U.S.P.Q.2d 1438, 1442 (Fed. Cir. 1991). In this instance, from the information detailed above, it is clear that Chu and Nakabayashi fail to teach or suggest all the limitations of Applicant's claims. Accordingly, Chu in view of Nakabayashi does not disclose all of the elements of

claims 1 and 12. Therefore, this rejection must fail. Thus, claims 1 and 12 are not anticipated by Chu and Nakabayashi and should be allowed.

In reference to claims 2-11 and 14-16, dependent claims are nonobvious under section 103 if the independent claims from which they depend are nonobvious. *Hartness Int'l, Inc. v. Simplimatic Eng'g Co.*, 819 F.2d 1100, 1108, 2 USPQ2d 1826, 1831 (Fed. Cir. 1987); *In re Abele*, 684 F.2d 902, 910, 214 USPQ 682, 689 (CCPA 1982); see also *In re Sernaker*, 702 F.2d 989, 991, 217 USPQ 1, 3 (Fed. Cir. 1983). Thus, claims 2-11 and 14-16 are not unpatentable over Chu in view of Nakabayashi and should be allowed.

Regarding added claims 17 and 18, Chu does not disclose membranes made from a hydrophobic synthetic polymer combined with a hydrophilic polymer, nor does Chu disclose methods for producing such membranes. Chu relates to skinless hydrophilic organic polymer microporous filter membranes modified with a charge modifying amount of an anionic charge modifying agent bonded to substantially all of the membrane microstructure (see Chu, Claim 1) whereby polyamide ("nylon") membranes, polyvinylidene fluorid membranes, cellulose acetate/-nitrate

membranes are named as hydrophilic microporous membranes.

(Column 6, Line 54 to Column 8, Line 68; Examples).

Additionally, Nakabayashi relates neither to membranes made from a hydrophobic synthetic polymer in combination with a hydrophilic polymer nor to methods for producing such membranes. The membranes of Nakabayashi are made from synthetic polymers only selected from the polymers listed in paragraph [13] of Nakabayashi without the addition of a hydrophobic polymer which accounts for hydrophilicity of the membrane. Nakabayashi indeed delimits from such membranes. (Page 1, Paragraphs 3-5).

Conclusion

In view of the foregoing, Applicant respectfully requests an early Notice of Allowance in this application.

Respectfully submitted,



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Electrolyte

From Wikipedia, the free encyclopedia

In chemistry, an **electrolyte** is any substance containing free ions that make the substance electrically conductive. The most typical electrolyte is an **ionic solution**, but molten electrolytes and solid electrolytes are also possible.

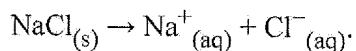
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Principles

Electrolytes commonly exist as solutions of acids, bases or salts. Furthermore, some gases may act as electrolytes under conditions of high temperature or low pressure. Electrolyte solutions can also result from the dissolution of some biological (e.g., DNA, polypeptides) and synthetic polymers (e.g., polystyrene sulfonate), termed polyelectrolytes, which contain charged functional group.

Electrolyte solutions are normally formed when a salt is placed into a solvent such as water and the individual components dissociate due to the thermodynamic interactions between solvent and solute molecules, in a process called solvation. For example, when table salt, NaCl, is placed in water, the salt (a solid) dissolves into its component elements, according to the dissociation reaction



It is also possible for substances to react with water when they are added to it, producing ions, e.g., carbon dioxide gas dissolves in water to produce a solution which contains hydronium, carbonate, and hydrogen carbonate ions.

Note that molten salts can be electrolytes as well. For instance, when sodium chloride is molten, the liquid conducts electricity.

An electrolyte in a solution may be described as *concentrated* if it has a high concentration of ions, or *dilute* if it has a low concentration. If a high *proportion* of the solute dissociates to form free ions, the electrolyte is *strong*; if most of the solute does not dissociate, the electrolyte is *weak*. The properties of electrolytes may be exploited using electrolysis to extract constituent elements and compounds contained within the solution.

Physiological importance

In physiology, the primary ions of electrolytes are sodium(Na^+), potassium (K^+), calcium (Ca^{2+}), magnesium (Mg^{2+}), chloride (Cl^-), hydrogen phosphate (HPO_4^{2-}), and hydrogen carbonate (HCO_3^-). The electric charge symbols of plus (+) and minus (−) indicate that the substance in question is ionic in nature and has an

imbalanced distribution of electrons, which is the result of chemical dissociation.

All known higher lifeforms require a subtle and complex electrolyte balance between the intracellular and extracellular milieu. In particular, the maintenance of precise osmotic gradients of electrolytes is important. Such gradients affect and regulate the hydration of the body, blood pH, and are critical for nerve and muscle function. Various mechanisms exist in living species that keep the concentrations of different electrolytes under tight control.

Both muscle tissue and neurons are considered electric tissues of the body. Muscles and neurons are activated by electrolyte activity between the extracellular fluid or interstitial fluid, and intracellular fluid. Electrolytes may enter or leave the cell membrane through specialized protein structures embedded in the plasma membrane called ion channels. For example, muscle contraction is dependent upon the presence of calcium (Ca^{2+}), sodium (Na^{+}), and potassium (K^{+}). Without sufficient levels of these key electrolytes, muscle weakness or severe muscle contractions may occur.

Electrolyte balance is maintained by oral, or in emergencies, intravenous (IV) intake of electrolyte-containing substances, and is regulated by hormones, generally with the kidneys flushing out excess levels. In humans, electrolyte homeostasis is regulated by hormones such as antidiuretic hormone, aldosterone and parathyroid hormone. Serious electrolyte disturbances, such as dehydration and overhydration, may lead to cardiac and neurological complications and, unless they are rapidly resolved, will result in a medical emergency.

Measurement

Measurement of electrolytes is a commonly performed diagnostic procedure, performed via blood testing with ion selective electrodes or urinalysis by medical technologists. The interpretation of these values is somewhat meaningless without analysis of the clinical history and is often impossible without parallel measurement of renal function. Electrolytes measured most often are sodium and potassium. Chloride levels are rarely measured except for arterial blood gas interpretation since they are inherently linked to sodium levels. One important test conducted on urine is the specific gravity test to determine the occurrence of electrolyte imbalance.

Sports drinks

Electrolytes are commonly found in sports drinks. In oral rehydration therapy, electrolyte drinks containing sodium and potassium salts replenish the body's water and electrolyte levels after dehydration caused by exercise, diaphoresis, diarrhea, vomiting, intoxication or starvation. Athletes exercising in extreme conditions (for three or more hours continuously e.g. marathon or triathlon) who do not consume electrolytes, risk dehydration (or hyponatremia).

Because sports drinks typically contain high levels of sugar, they are not recommended for regular use by children. Water is considered the only essential beverage for children during exercise. Medicinal rehydration sachets and drinks are available to replace the key electrolyte ions lost during diarrhea and other gastrointestinal distresses. Dentists recommend that regular consumers of sports drinks observe precautions against tooth decay.

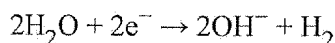
A simple electrolyte drink can be home-made by using the correct proportions of water, sugar, salt, salt substitute for potassium, and baking soda.^[1] However, effective electrolyte replacements should include all electrolytes required by the body, including sodium chloride, potassium, magnesium, and calcium that can be either obtained in a sports drink or a solid electrolyte capsule.^[2]

Electrochemistry

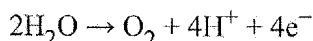
Main article: electrolysis

When electrodes are placed in an electrolyte and a voltage is applied, the electrolyte will conduct electricity. Lone electrons normally cannot pass through the electrolyte; instead, a chemical reaction occurs at the cathode consuming electrons from the anode, and another reaction occurs at the anode producing electrons to be taken up by the cathode. As a result, a negative charge cloud develops in the electrolyte around the cathode, and a positive charge develops around the anode. The ions in the electrolyte move to neutralize these charges so that the reactions can continue and the electrons can keep flowing.

For example, in a solution of ordinary salt (sodium chloride, NaCl) in water, the cathode reaction will be



and hydrogen gas will bubble up; the anode reaction is



and oxygen gas will be liberated. The positively charged sodium ions Na^+ will react towards the cathode neutralizing the negative charge of OH^- there, and the negatively charged chlorine ions Cl^- will react towards the anode neutralizing the positive charge of H^+ there. Without the ions from the electrolyte, the charges around the electrode would slow down continued electron flow; diffusion of H^+ and OH^- through water to the other electrode takes longer than movement of the much more prevalent salt ions.

In other systems, the electrode reactions can involve the metals of the electrodes as well as the ions of the electrolyte.

Electrolytic conductors are used in electronic devices where the chemical reaction at a metal/electrolyte interface yields useful effects.

- In batteries, two metals with different electron affinities are used as electrodes; electrons flow from one electrode to the other outside of the battery, while inside the battery the circuit is closed by the electrolyte's ions. Here the electrode reactions convert chemical energy to electrical energy.
- In some fuel cells, a solid electrolyte or proton conductor connects the plates electrically while keeping the hydrogen and oxygen fuel gases separated.
- In electroplating tanks, the electrolyte simultaneously deposits metal onto the object to be plated, and electrically connects that object in the circuit.
- In operation-hours gauges, two thin columns of mercury are separated by a small electrolyte-filled gap, and, as charge is passed through the device, the metal dissolves on one side and plates out on the other, causing the visible gap to slowly move along.
- In electrolytic capacitors the chemical effect is used to produce an extremely thin 'dielectric' or insulating coating, while the electrolyte layer behaves as one capacitor plate.
- In some hygrometers the humidity of air is sensed by measuring the conductivity of a nearly dry electrolyte.
- Hot, softened glass is an electrolytic conductor, and some glass manufacturers keep the glass molten by passing a large current through it.

Dry electrolyte

Dry electrolytes are essentially gels in a flexible lattice framework.^[3]

See also

- Strong electrolyte
- ITIES (Interface between Two Immiscible Electrolyte Solutions)

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chemical- Galvanic *e.* **dynamic-** Current or galvanic as opposed to static *e.* It indicates electrons in movement. It may be generated by chemical reaction (voltaic), induction (faradic), or magnets (magnetic). **faradic-** Induced *e.* A current of high voltage produced in a secondary coil when a galvanic current passes through the primary coil of an induction machine. **frictional-** Static *e.* obtained by friction, e.g., rubbing a glass rod with fur. **galvanic-** Dynamic. **induced-** Faradic. **negative-** A current of electrons passing from anode to cathode outside, and from cathode to anode inside, a galvanic cell. **photo-** See *photoelectricity*. **positive-** (1) An absence or deficiency of negative electrons. (2) A current in the direction opposite to negative. According to this convention, a current flows from negative to positive. **static-** Frictional, as opposed to dynamic. It indicates electrons accumulated at rest, and their sudden escape from the surface of an insulated conductor. **thermo-** (1) *E.* produced by heat. (2) The heating effects of *e.* **tribo-** *E.* produced by friction. **voltaic-** A current produced by an electric battery.

electrification. Charging with electricity or electrons. **electrify.** To charge with electricity.

electron. Early name for electron.

electroaffinity. E or E_0 . Electrolytic potential. The electrode potential, q.v., for a concentration corresponding with 1 gm ion/liter of ions liberated from an electrode. See *electromotive force*.

electroanalysis. Analytical methods based on electrolysis or conductometry; as, electrometric titration.

electrochemical. Pertaining to both chemistry and electricity. ***e.* constant.** Faraday. ***e.* deposition.** The formation of a metallic layer by electrolysis for: (1) recovery of metals from ores, or refining metals; (2) electroplating, to produce a protective or ornamental coating, or for reproduction, e.g., in photoengraving. ***e.* equivalent.** E . The mass in grams of any element deposited from an electrolytic cell by an electric current of 1 coulomb: $E = (A/V)0.000,010,36$, where A is the atomic weight, and V the valency of the element. Cf. *Faraday's law*. ***e.* machining.** Finishing an article by making it an *e.* anode, the cathode being shaped to impart the required form when material is transferred to it from the anode by electroplating in reverse. ***e.* series.** Displacement series. ***e.* spectrum.** A current-voltage graph produced by the polarograph, q.v.

electrochemistry. The science of transforming chemical into electrical energy, and vice versa.

electrocratic. Describing a colloid stabilized by an electric charge.

electrode. The device by which an electric current passes into or out of a cell, apparatus, or body. It may be a simple wire or complex device, (hydrogen *e.*) or the container of the cell itself. **auxiliary-** A standard *e.* used during electrodeposition to measure the potential at which this occurs. **calomel-** See (1) *calomel e.*, (2) *Hildebrand e.* **capillary-** See *Lippmann e.* **dropping-** A standard *e.* formed by a stream of mercury falling in fine droplets through a capillary tube into the electrolyte. A fresh surface is thus obtained continuously. Cf. *polarograph*, *Heyrovsky. gas-* See *gas e.* **gas-jet-** See *sprudel effect*. **glass-** A thin glass membrane

separating solutions of known and unknown pH value, the potential difference between the 2 sides being measured. **Hildebrand- q.v.** **hydrogen- q.v.** **negative-** The cathode, negode, or negatively charged pole, by which the current "passes out," and to which anions are attracted. **positive-** The anode, posode, or positively charged pole, by which the current "enters," and to which cations are attracted. **quinone- q.v.** **reversible-** An *e.* which owes its potential to reversible ionic changes as $H_2 \rightleftharpoons 2H^+ + 2e^-$.

***e.* potential.** The tendency, expressed in volts, of a metal to dissolve in a solution containing its ions. The algebraic difference of the 2 *e.* potentials of the electrodes gives the voltage E of the cell $= E_0 + (0.058/n) \log C$, where C is the concentration in gram ions per liter of the ions given off by the *e.*, E_0 the electroaffinity, n the valency of the ion.

electrodeposition. The precipitation of a metal on an electrode. ***e.* analysis.** The quantitative *e.* of an element from a solution. The electrode is weighed before and after deposition.

electrodynamics. The study of moving charges.

electrodynamometer. An instrument to measure the intensity of faradic and alternating currents.

electroencephalogram. An electrical record of the waveform of electric currents developed in the human brain.

electroendosmosis. The production of endosmosis, q.v., by an electric potential.

electroforming. The production of metallic tubes, sheets, or patterns by electrolysis.

electrographic analysis. The qualitative analysis of a metallic surface by placing it in contact with a gelatin-coated paper saturated with an electrolyte and making it the anode of an applied electric current. After removal of the electrolyte, a suitable reagent is added to the paper. Any suitable other metal may be used as electrode on the other side of the paper.

electroleless deposition. The deposition of a metal in solution on another solid metal by chemical means, instead of by means of an electric current as in electrodeposition, e.g., by the reducing action of hypophosphites in nickel plating.

electroluminescence. Electrophotoluminescence. The adiabatic emission of light by certain substances when placed in an electric field.

electrolysis. The separation of the ions of an electrolyte hence, the decomposition of a compound, liquid, molten, or in solution, by an electric current. Cf. *electrochemical decomposition*. **internal-** The separation of a metal in the presence of a much more electropositive (i.e., baser) metal, by inserting an anode of the baser metal in the solution, and connecting it directly with a platinum cathode on which the metal is deposited. No external current is required; e.g., Cu on Zn immersed in $CuSO_4$ solution.

electrolyte. (1) A substance that dissociates into 2 or more ions, to some extent, in water. Solutions of *e.* thus conduct the electric current and can be decomposed by it (*electrolysis*). (2) Sulfuric acid, d.1.150-1.835, used in batteries and accumulators. **non-** A substance that does not dissociate into ions. **strong-** An *e.* that is highly dissociated even at moderate dilutions, and does not obey Ostwald's

ELECTROLYTE

ven and unknown pH
e between the 2 sides
l- q.v. **hydrogen-** q.v.
gode, or negatively
current "passes out,"
racted. **positive-** The
charged pole, by which
to which cations are
versible- An e. which
ible ionic changes as

ty, expressed in volts,
olution containing its
ce of the 2e. potentials
voltage E of the cell
re C is the concentra-
of the ions given off
by, n the valency of the

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hotoluminescence. The
by certain substances
ield.

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sion of a compound,
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osition. **internal-** The
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baser) metal, by in-
r metal in the solution,
with a platinum cathode
e deposited. No external
Cu on Zn immersed in

that dissociates into 2
t, in water. Solutions of
ric current and can be
sies). (2) Sulfuric acid,
series and accumulators.
not dissociate into ions.
hly dissociated even at
oes not obey Ostwald's

ELECTROLYTIC

dilution law. **weak-** An e. that is fully or partly
dissociated only at high dilution, and obeys the
dilution law.

electrolytic. Pertaining to decomposition by an
electric current. **e. apparatus.** An ammeter,
voltmeter, rheostat, and rotating platinum anode
for quantitative electrodeposition. **e. dissociation.**
Ionization. **e. gas.** A mixture of hydrogen
(2 vol.) and oxygen (1 vol.) obtained by electrolysis
of water. **e. potential.** Electroaffinity. **e. separa-**
tion. The graded electrodeposition, q.v., of
metals from a solution, by varying the applied
potential according to the electrode potentials of
the metals. **e. solution tension theory.** Nernst
theory.

electrolyze, electrolyse. To subject to electrolysis.
electromagnet. Soft iron around which is wound
an insulated wire; while an electric current passes
through the wire, the iron is magnetized.

electromagnetic. Pertaining to electricity and mag-
netism. **e. field.** The area of force surrounding
an electromagnet or a conductor through which a
current flows. The intensity of the magnetic
field at the center of a circular conductor of radius
 r is $2i/r$, where i is the current. **e. law.** See
Coulomb. **e. radiation.** See *radiation*. **e. separa-**
tion. The separation of the magnetic constituents
of ores by means of an electromagnet. **e. units.**
emu. A system of electrical units based on
dynamics; it includes the practical units (volts,
ampere, ohm, etc.) which are multiples or fractions
of the cgs e. units. See *electrical units* (table).

electromerism. Mobile electron tautomerism shown
by a set of compounds, the electron constellations
of which vary in position, although the atomic
kernels do not. Cf. *chelate bond*.

electromers. Isomers that differ in the distribution
of electrons among their atoms.

electrometer. An instrument to measure the
quantity or intensity of an electric current.
absolute- Galvanometer. Ammeter. **capillary-** A
null-point e. which detects 1 mv by the motion,
in a capillary tube, of a dilute sulfuric acid-
mercury interface. **emanation-** See *emanation*.
photo- Photogalvanometer. **quadrant-** Galvano-
scope.

electromotion. Mechanical action produced by
electricity.

electromotive. In motion produced by electricity.
e. force. e, emf. Electric pressure, voltage. The
work, in volts per unit quantity of electricity
flowing through a cell.

1 international volt = 1.00043 absolute volts

1 absolute volt = 0.99957 international volt

= 1 practical emu

= 10^8 cgs emu

= 0.0033349 esu

For molar concentrations the emf of an electrolytic
cell is the algebraic difference between the electro-
affinities, q.v., of the ions of the metals forming the
electrodes. See *electrode potential*. **e. series.**
Displacement series.

electron. (1) An alloy: Mg 90, Al 5%, and a little
Zn, Mn, or Cu. (2) Negatron, β particle. An
elementary unit of electricity, or a negatively

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ELECTRON

charged corpuscle, whose accumulation on an in-
sulated conductor produces static electricity, and
whose flow through a conductor produces an
electric current. Electrons are in the atomic
nucleus and atomic shell, and their number and
arrangement account for valency and other
properties. Electrons are liberated from the atom
by radioactive disintegration, and transferred from
one atom to another in oxidation-reduction
reactions (electronation). They are made visible
by the Wilson track method, and Millikan's fog
chamber. Their mass changes with their velocity.
Constants are:

Mass..... 9.035×10^{-28} gm

Charge..... 4.8029×10^{-10} esu

or 1.602×10^{-20} emu

Spin (angular momentum).... 9.02×10^{-28} erg-sec

Cf. e, atom. **Auger-** See secondary electron spec-
troscopy. **binding-** An e. which holds together
the positive charges in the atomic nucleus.
cementing- An e. which is assumed to hold together
the 2H nuclei of the helium atom. **free-** (1) A
corpuscle or charge of negative electricity (mass
 9.01×10^{-28} gm). (2) An e. in an atom which is
not shared by another atom. **heavy-** Yukawa
particle. A penetrating component of cosmic
rays, having an electronic charge greater than that
of an e., but less than that of a proton. **metastasic-**
An e. which changes its position in the atom
owing to radioactive changes; generally moving
from the valence orbit into the interior. **negative-**
Negatron or free e. Cf. *positive e. nuclear*. **E.** of the
atomic nucleus. **orbital-** E. in the orbit of an
atom. **paired-** One of 2 electrons constituting a
nonpolar bond, q.v. Cf. *twin e. phoretic*. **E.** which
conduct by passing freely from atom to atom when
their outer orbits are in contact. **photo-** E.
liberated from a surface by exposure to light.
piezo- A supposedly disk-shaped e. in the helium
nucleus. **positive-** (1) A heavy small corpuscle asso-
ciated with a mass more than that of hydrogen; is
assumed to be an H nucleus or atom from which an
e. has been removed. (2) Positron, q.v. A particle
of nearly zero mass with a positive charge. **recoil-**
E. scattered by bombardment of a substance with
 α or β rays. **secondary-** Auger. E. emitted by a
metal surface irradiated with X rays of 150-200
kv frequency. They affect photographic film to
extents that depend on the atomic number of the
surface metal and are used in qualitative analysis.
twin- See *paired e. valency*. The 1 to 8 electrons
in the outer orbit of an atom which are responsible
for valency. They can pass from one atom to the
other (polar bond) or be held in common by 2
atoms (nonpolar bond). See *bond, valency*.

e. affinity. The capture by a substance, e.g., an
oxidizing agent, of the electrons of other substances.
See *electronate*. **e. beam.** A stream of electrons,
as in a cathode tube. **e. compounds rule.** The
position of the phase boundaries, at room tempera-
ture, in the equilibrium diagram of a binary alloy
depends on the e. concentration. **e. diffraction.**
The diffraction of a stream of electrons by a surface.
Cf. e. microscope. **e. displacement.** A shift of an
e. pair held in common between 2 atomic nuclei,
toward one nucleus. See *Lucas theory*. **e. distri-**
bution curve. A curve showing the e. distribution

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New York San Francisco Toronto London Sydney

intensity of the field. Cf. dl- The accumulation of negative electrode of a sized light in circular sized light in elliptical sized light, the vibrations in one plane.

nt-voltage curve obtained n electrolytic current is izing electromotive force. potential. The reverse e cell, tending to oppose ting electrolytic decom- o p. (2). Cf. *overvoltage*.

zation. s of 2 types of rays whose ions at right angles: the dry rays. The ordinary meter by total reflection, r emerges as light polar- ically active substances iation, *Verdet*.

arizing light; as, a nicol t vibrating only in one s a filter by transmitting us |||||, which, on passing e substance, are rotated *alyzer*.

zation. p. angle. See Polaroid. A cellulose d iodoquinine sulfate n 2 glass plates; a sub- polarimeters; and used lasses, and windshields

ber. The mathematical ssigning to each atom in or negative integer: H . oxidation, reduction,

urve. The current-volt- larograph. It indicates substances electrolytic- hode potentials.

t that records photo- es in the intensity of a e gradually increasing ysis with a dropping o measure deposition or ions, overvoltage, ionic a, solubility; and for ive microanalysis. Cf.

s, q.v. p. vectograph. ich the p. is used to

duced in an aqueous is associated with one and it polarizes the

a polythene synthetic

$I_{29}O_7NS = 451.45$. 39, soluble in water; a

points at the opposite s that have opposite ive- The cathode: an

electric terminal charged with electrons. (mag- netic) north- That point toward which a freely suspended magnetic needle will point. positive- The anode: an electric terminal that becomes positively charged by loss of electrons.

Polenske number. The number of milliliters of 0.1 normal alkali (less the blank) to neutralize an alcoholic solution of the water-insoluble volatile fatty acids liberated on acidification of the soap made by saponification of 5 grams of a fat. Cf. *Reichert number*.

polianite. Pyrolusite.

policeman. A device to remove precipitates from the walls of glass vessels in quantitative analysis.

platinum- A platinum-iridium alloy claw that fits over a glass rod, to hold a quantitative filter during ignition. rubber- A small piece of rubber tubing fitting snugly over the end of a glass rod.

polishing. Rubbing or smoothing metal or glass surfaces. electrolytic- Smoothing a metal surface by making it the anode in a suitable electrolyte (usually phosphoric acid and glycerin). The high current density produced on the small projecting portions results in their preferential dissolution.

polishing slate. Gray or yellow slate used for polishing.

Pollack's cement. A stiff paste of equal weights of red lead and litharge, in gelatin, for jointing metal and/or glass; slow-setting but strong.

pollantin. An antitoxin obtained by inoculating horses with pollen extract; used for immuniza- tion.

pollen. The male sex cells or fertilizing grains of a flowering plant, which contain glucosides; e.g.: ragweed p., quercitin; timothy p. (*Phleum pratense*), dactylin. Cf. *stamen*. p. extract. A solu- tion of proteins from the pollens of plants believed to cause hay fever; used for immunization. fall- An extract of the proteins of ragweed, goldenrod, and maize. spring- An extract of the proteins of rye, timothy, orchard grass, redtop grass, and sweet vernal grass; used for immunizing to hay fever.

Pollopas. Trade name for a glasslike transparent plastic; a glass substitute.

pollucite. $Cs_2O \cdot Al_2O_3 \cdot 5SiO_2 \cdot H_2O$. Polhux. A rare, native silicate, in pegmatite (Island of Elba).

pollution. (1) Contamination. (2) The introduction of a deleterious substance into a water supply.

pollux. Pollucite.

polonium. Po = 218.2. Radiotellurium, dvtel- lurium. The radioactive element RaF, at. no. 84, formed by disintegration of radium, and belonging to the sixth group of the periodic system; the first radioactive decomposition product, discovered by Madame Curie (1898).

poly- Prefix (Greek) meaning many. (Latin: multi.)

polyacetylenes. Unbranched carbon chain com- pounds, sometimes part of a ring structure, C_{10} to C_{13} predominating; formed by plants (hydrocar- bons) and microorganisms (alcohols and acids).

polyacid base. A compound that yields 2 or more hydroxyl ions; as, $Ca(OH)_2$.

polyactivation. Activation e.g., of fluorescence, by more than one substance.

polyad. An element or radical with a valency greater than 2, e.g., triad.

polyadelphite. A brown to green manganese garnet. polyalkane. A hydrocarbon polymer of long-chain molecules containing only saturated atoms in the main chain.

polyallomers. Plastics having a highly crystalline and stereoregular structure, and consisting of chains of polymerized crystalline segments of each of the constituent olefinic monomers. Specially suitable for blow-molding and extrusion processes, e.g., propylene-ethylene p.

polyamide. A polymer, usually of a carboxylic acid (e.g., adipic acid) and its aminated derivative, in which the structural units are linked by amide or thioamide groupings; many have fiber-forming properties. Cf. *nylon*.

polyargyrite. A native silver-antimony sulfide.

polyatomic. (1) Describing a molecule with 3 or more atoms (2) Polybasic. (3) Polyacidic. (4) De- scribing an organic compound containing 2 or more hydroxyl groups; as, glucose.

polybasic acid. A compound that yields 2 or more H ions per molecule in aqueous solution; as, H_2SO_4 .

polybasite. Ag_3SbS_4 . A native sulfide, containing copper.

polybutylenes. Polybutenes. Polymers of butylene, ranging from viscous to rubbery substances.

polycaprolactam. Nylon 6. A polyamide synthetic fiber.

polycarbonates. Thermoplastic linear polyesters of carbonic acid, made by the polymeric condensation of bisphenols with a phosgene or its derivatives. Used for injection molding, especially where clarity is important.

Polycarpeae. A group of families of Phanerogams (Nymphaeaceae, Ranunculaceae, Magnoliaceae, Myristicaceae, Menispermaceae, Berberidaceae, Lauraceae).

polyceptor. An amboceptor that binds different complements.

polychloral. Hydronal.

Polychol. Trademark for surfactant condensation products of polyoxethylene and wood alcohols.

polychrom. Eucalin.

polychromatic. Showing more than one color, particularly if viewed by polarized light. pseudo- Pseudodichromatic, pseudodichroic. Showing more than one color when viewed by polarized light, but otherwise colorless.

polychromatophile. Describing a cell or tissue that can be stained differentially with dyes.

polycondensation. A form of polymerization in which recurring structural units are formed from simpler molecules by elimination of a simple substance, e.g., water.

polycrase. Euxenite.

polycyclic. Polynucleated. Describing a molecule that contains 2 or more atomic rings; as, naph- thalene. Cf. *ring systems*.

polydymite. $(Ni, Co)_4S_8$. A native sulfide.

polyelectrolyte. A polymer producing large chain- type ions in solutions, that can carry positive or negative groups along the polymer chain; used as industrial flocculants.

polyene. A compound containing many double bonds; as, the carotenoids. p. grouping. A system of double bonds associated with color reactions; as, in carotene.

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Chapter 1

INTRODUCTION

I. CHARACTERIZATION OF POLYELECTROLYTES

Polyelectrolytes are macromolecules having many ionizable groups. In solution they are dissociated into polyvalent macroions (polyions) and a large number of small ions of opposite charge (counter ions). The high charge of the macroion produces a strong electric field which attracts these counter ions. This strong electric interaction between the polyvalent macroion and counter ions is a source of the characteristic properties of polyelectrolytes. The activity coefficient of counter ions is very low even at low concentrations of polyelectrolytes, and the dielectric constant of polyelectrolyte solutions is extremely large.

The electrical effect of the highly charged macroion is expected to be screened when an increasing concentration of small ions is introduced, e.g., by the addition of simple electrolytes. Experiments, however, lead to a simple empirical law which describes the thermodynamic and transference properties of polyelectrolyte—simple electrolytes mixtures as a superposition of the contributions of ions from polyelectrolyte and the simple electrolytes. This result is also attributable to the characteristic interaction between the polyvalent macroion and small ions.

As in the case of nonelectrolytic macromolecules, the morphology of polyvalent macroions is one of the central problems of polyelectrolytes. Most of the macroions are long flexible chains having a large extension in solution. Their size and shape depend on the charge and the interaction with counter ions. With increasing charge, the flexible chain changes its shape from a contracted random coil to a fully extended one. This cor-

POLYELECTROLYTES

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MARCEL DEKKER, INC., New York 1971

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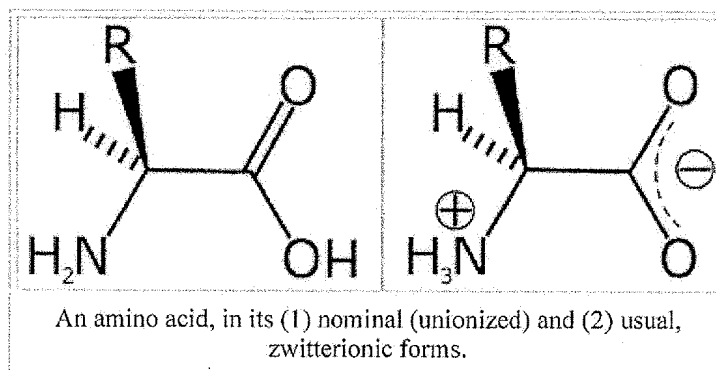
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Zwitterion

From Wikipedia, the free encyclopedia

A **zwitterion** (first part pronounced *TSVIT-ər*, from German "*Zwitter*" ([ˈtsvɪtɐ]) = hybrid, hermaphrodite) is a chemical compound that carries a total net charge of 0 and is thus electrically neutral, but carries formal charges on different atoms.

Some chemists restrict the term to compounds with the charges on non-adjacent atoms.^[1] This would exclude compounds such as *N*-oxides and ylides, which have a charge on adjacent atoms, specifically, nitrogen and carbon being the cations, respectively. Zwitterions are polar and are usually very water-soluble, but poorly soluble in most organic solvents.



Ampholytes are molecules that contain both acidic and basic groups (and are therefore amphoteric) and will exist mostly as zwitterions in a certain range of pH. The pH at which the average charge is zero is known as the molecule's *isoelectric point*.

Applications

Ampholytes are used to establish a stable pH gradient for use in isoelectric focusing.

Typical examples of zwitterions are:

- Most amino acids at physiological pH are zwitterionic.
- Used as buffering agents in Good's buffers:
 - The amino-sulfonic acid based MES, MOPS, HEPES, PIPES or CAPS
 - The amino-carboxylic acid (amino acid) based glycine, its derivatives bicine and tricine, and alanine
- Used as detergents:
 - CHAPSO
- Natural products like the alkaloids psilocybin and lysergic acid.
- Betaines

Less common examples of zwitterions are:

- Quinonoid zwitterions.
- Drugs such as Fexofenadine (Allegra) and Cephaloridine.
- decaphenylferrocene [$(\eta^5\text{-C}_5\text{Ph}_5)_2\text{Fe}$] has been shown to have a zwitterionic linkage isomer [$(\eta^5\text{-C}_5\text{Ph}_5)\text{Fe}^+(\eta^6\text{-C}_6\text{H}_5\text{C}_5\text{Ph}_4^-)$].

References

1. ^ International Union of Pure and Applied Chemistry. "zwitterionic compounds/zwitterions". *Compendium of Chemical Terminology* Internet edition.

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